BE / B Tech (Full Time) DEGREE END SEMESTER EXAMINATIONS APRIL / MAY 2011

29

MATERIALS SCIENCE & ENGINEERING BRANCH

SIXTH SEMESTER

ME-9030 – INDUSTRIAL TRIBOLOGY

(REGULATIONS 2008)

Time : 3 hrs. Max. Mark : 100

Instructions : 1. Read questions carefully. Write 'to the point' answers

2. Question Nos. 1 to 11 are compulsory

Answer ALL Questions

Part – A (10 x 2 = 20 Marks)

1. Define R.M.S. value of roughness.
2. Show four instances where the contact between engineering components are defined by circular arcs.
3. What is plasticity index? How is it used?
4. Name four operating parameters that affect the coefficient of friction.
5. Mica does not obey Amonton's laws of friction. Justify.
6. Write brief note on 'friction of lamellar solid'.
7. Name four synthetic organics that are used as lubricants.
8. Draw the shear stress vs. shear rate plot for (a) dilatant fluid and (b) Bingham plastic
9. What are the basic differences between the hydrodynamic and hydrostatic lubrication systems?
10. What is stick-slip process?

Part – B (5 x 16 = 80 Marks)

11. (a) What are the four types of erosive wear? Describe *any three* of these processes. (2+6)

(b) Define abrasive-wear-resistance. Discuss the dependence of abrasive-wear-resistance on *any three* of the following parameters: i) hardness, ii) elastic modulus, iii) heat-treatment and iv) grain orientation. (2+6)

12. (a) (i) What are the material requirements for the *cage* of a rolling element bearing? Justify.
(ii) Name three different material systems suitable for bearing cage.
(iii) Why whitemetals (babbitts) are selected for the low stress application in case of fluid film lubrication?
(iv) Write brief notes on 'effect of metallurgical conditions on wear' (4+2+3+7)

OR

(b) (i) Explain the effect of (A) *oxide film*, (B) *normal load* and (C) *vacuum* on wear of materials. (8)
(ii) Derive the ploughing coefficient of friction for the case of a conical asperity. Calculate μ_P if the asperity semi angle is 45°. (4)
(iii) Explain why '*wear rate*' is not a meaningful parameter in describing the *useful life* of rolling element bearing. (4)

13. (a) (i) State the basic principles of the following surface engineering processes:
(A) *transformation hardening*, (B) *pack carburizing*, (C) *chemical vapour deposition*. (8)
(ii) Write short notes on: '*Frictional considerations in design for material selection*' for the cases of (A) high vacuum, (B) very high speed and (C) very low temperature. (8)

OR

(b) (i) Write short notes on: (A) surface melting, (B) nitro-carburizing and (C) physical vapour deposition. (8)
(ii) Write short notes on '*Frictional considerations in design* for the *normal condition* of operation'. (8)

14. (a) (i) What is *Auto Correlation function* (ACF)? What does it reveal? (2+2)
(ii) A sample of a surface profile consists of 100 triangular asperities having a constant flank angle (semi angle) α and maximum peak-valley heights of 1, 2, 3, ...,100 microns. Assuming that the valleys lie at the same level, find the position of the centre-line and calculate the C.L.A. value of the profile. (6)
(iii) State the *Bowden & Tabor's simple adhesion theory* of friction. What are the drawbacks of this theory? (4+2)

OR

(b) (i) Write brief note on '*modified adhesion theory*'. (4)

(ii) Derive Archard's equation for adhesive wear stating the *assumptions* clearly. (6)

(iii) The flat face of a brass annulus having an outside diameter of *20 mm* and an inside diameter of *10 mm*, is placed on a flat carbon-steel plate under a normal load of *10 N* and rotates about its axis at *100 rpm* for *100 hour*. As a result of wear during the test, the mass losses of the brass and steel are *20 mg* and *1 mg*, respectively. Calculate *wear coefficients* for the bronze and the steel.

Use: hardness of steel = *2.5 GPa*, hardness of brass = *0.8 GPa*, denity of steel = *7.8 Mg/m^3*, denity of brass = *8.5 Mg/m^3*. (6)

15. (a) (i) Consider the *step bearing* as shown in ***Fig. 1***. Starting from the *Reynolds equation* for pressure gradient for the longitudinal motion, obtain the *pressure distribution function, p(x)*, along the length of the step bearing. (8)

(ii) Also, derive the expression for *load capacity* for the step bearing in terms of maximum pressure, p_S. (4)

(iii) Define *reduced pressure parameter*. Why is it used? (4)

OR

(b) (i) Consider the slider bearing as shown in ***Fig. 2***. Starting from the *Reynolds equation* for pressure gradient for the longitudinal motion, obtain the *pressure distribution function, p(x)*, along the length of the slider bearing. (8)

(ii) Also, derive an expression for the location ($\dot{x}$) of maximum pressure.
What is the value of maximum pressure? (2+2)

(iii) Draw a *journal bearing* and state its *working principle*. (4)

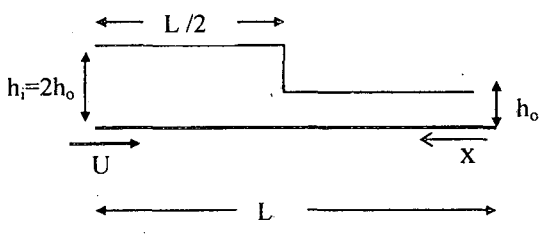

Fig. 1

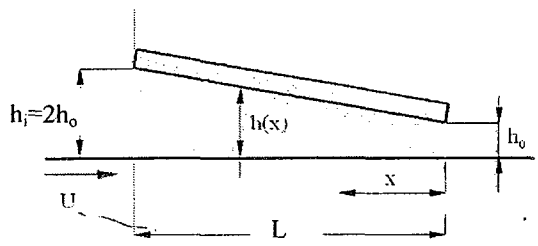

Fig. 2